Additional information on the project “Axial buckling of a bilayer cylinder” intended for future IIB project students at CUED.

This document aims to aid any future students who continue this project. This is NOT part of my (Felix Daines, fd387) submission to my 4th year project (Report, log book etc) – this is only to help future students and is not intended to be read by my assessor.

As discussed in my final report, I did several distinct sections of work as part of my project. I will give additional info and files relating to each of these so that if these are to be worked in further, the dead ends and time wasting I found need not be repeated.

Abaqus

All simulations are run by creating input (.inp) files then submitted via the gui. (parallelisation in the options tab can speed these up significantly). This worked ok for me but for other work the gui alone may be sufficient if the geometry is not crazy complicated. Python files are provided that I used to create these. My apologies for the lack of coordination of these. Most of the files are old iterations. Effectively flat_plate_input.py and create_cylinder_input_3d_solid.py are the only two relevant ones. These write input files and allow lots of parameters to be varied: whether the simulation uses thermal expansion or compression etc. These should be relatively self-explanatory. I put a lot of work in to creating extra functions and future proofing these – I’m not sure this was worth it and I would say if the code is to be used in the same way again, hard coding certain things like boundary conditions isn’t the worst idea. Just get it working.

I spoke about this in my report a little but the choice of algorithm does affect the results, I got on well with the stabilise method – this could be explored more but did the job for me. I ran some simulations using batch files which worked without the abaqus gui. This was fine but is a bit of a pain to set up to probably not worth it unless you are literally running 100s of sims.

When creating the simulations, be very careful when specifying boundary conditions and element definitions, it is worth fully understanding the weird notation around this. Its not obvious when this fails so I’d recommend reading the docs on that if you want to play around with it.

I have included some example input files. P_50x50_pre creates imperfections by buckling a plate that can be read into other simulations. P_t_t10_E20 creates a plate

simulation with the film expanding under thermal expansion. This can also be done orthotropically (see docs).

I did also use python to read abaqus odb databases, code for this given. It did work and made graphs but I'm not it was worth it. The code to do this was a pain and wasn't all that useful. If your project needs lots of quantitative data from sims or you're much better at python than me then go for it but don't assume it will be quick and easy.

Physical experiments

I think the process for this is explained sufficiently in the report but I will just list some tips and pitfalls I found while doing this.

- For cylinders, ensuring a seal is hard, the silicone leaks a lot while setting, Ensuring a uniform thickness is hard, especially while prestressing, a rotating drum might solve this. But again this likely won't be simple or quick
- I tried to use tension to prestress cylinder but this wasn't very easy or successful
- Varying the mix ratio can affect the youngs modulus a lot but it has limits, these are given in the plot in the report. Also buy other products early if this will be useful, there is budget and they can be very helpful. I've used up all of the 30T but there is lots of 40T remaining. Bentley advanced materials were a good supplier and delivered quickly.
- Getting a good mix and uniform thickness (see my flat plates with bulges) is hard – it could be worth coming up with a better way of making this

All of this is just my experience and is by no means the only or correct approach. But I hope this information proves useful and your project is a success. If you want more CAD/photos/files please feel free to get in contact. I would also be interested to see where this work goes – please let me know if you get any interesting results!

Best of luck!

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June 2025